Light and Lighting

Official Journal of the Illuminating Engineering Society.

Incorporating "The Illuminating Engineer."

32, Victoria St., London, S.W.1.

Edited by J. STEWART DOW

Telephone : ABBey 5215

Vol. XXXVIII.—No. 11 November, 1945 PRICE NINEPENCE Subscription 10/6 per annum, post free

Christmas Greetings

(From the I.E.S. President)

As the festival which is traditionally associated with peace and goodwill draws near, I want to send this personal greeting to all Members of the I. E. S. Christmas this year, whatever customary comforts may be lacking for any of us, will, - once again, - be celebrated in peace. I hope that, for all of you, it will be a season of good cheer, as well as the prelude to a brighter future.

Sincerely Yours

H. C. Weston

Training in Illuminating Engineering

We have learned with great interest of the Course in Illuminating Engineering which Mr. F. M. Hale is conducting at the Stow College of Engineering, Glasgow. The course is intended to cover the syllabus of the Intermediate Examination in Illuminating Engineering of the City and Guilds of London Institute, both practical and theoretical instruction being provided. The class meets on Fridays from 7.15-9.45 p.m., and the fee for the course (extending over 26-30 weeks) is the very moderate one of 10s. On the first night (October 3), nine students were enrolled, but the number by the end of the month had increased to 16, with a prospect of more to come. Ages vary from 18 to 56 years, the average being about 30. This must be considered a very encouraging response in the present circumstances. One great local advantage is that students will have opportunities of handling photometric and other lighting equipment in the Glasgow Corporation Lighting Department, with which Mr. Hale is associated. One difficulty likely to be experienced by all lecturers initiating such courses is lack of knowledge of mathematics and other ancillary subjects, which may render some supplementary tuition necessary. Another evident lack mentioned by Mr. Hale is the absence of any satisfactory textbook on illuminating engineering for the use of students. This need, we are happy to learn, has been appreciated by the I.E.S. Council, and we understand that there is a prospect of a suitable textbook making its appearance next year.

American I.E.S. Convention

It has recently been announced that the 1946 National Convention of the Illuminating Engineering Society (U.S.A.) is to be held in Quebec City, Canada, during September 18-21. As readers are doubtless aware, such annual gatherings were held annually prior to the outbreak of war, and have invariably attracted keen audiences and useful papers. The Convention which it is proposed to hold in London in May, 1946, is a maiden effort by the Society in this country, and in present circumstances, perhaps, a somewhat courageous one. It should, however, meet with a ready response, even though the area from which visitors will be drawn is so much less than that covered by the American I.E.S. We understand that preparations are proceeding and that a further announcement may be expected shortly.

Forthcoming I.E.S. Meetings

(Provisional List)

SESSIONAL MEETINGS IN LONDON

1945.

Dec. 11th. DR. J. N. ALDINGTON on **Bright Light Sources (Part II).** (*At the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.*) **6 p.m.**

1946.

Jan. 8th. A Discussion on the **British Standard Specification for Street Lighting** will take place. (*In the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1.*) **6 p.m.**

MEETINGS OF CENTRES AND GROUPS

1945.

Dec. 3rd. MR. N. SCHOFIELD on **Public Lighting.** (*At the Sheffield University, Western Bank, Sheffield.*) **6 p.m.**

Dec. 4th. MR. B. BLOW on **Tungsten Filament Lamps.** (*In the Demonstration Theatre, Leicester Electricity Dept., Charles St., Leicester.*) **6 p.m.**

Dec. 5th. MR. R. O. ACKERLEY on **The Place of Science in the Art of Lighting.** (*In the Electricity Showrooms, Whitechapel, Liverpool.*) **6 p.m.**

Dec. 5th. MESSRS. G. R. HANSON and J. ROLPH on **Store and Shop Lighting.** (*In the Minor Hall, Oxford St., Newcastle-upon-Tyne.*) **5.45 p.m.**

Dec. 6th. MR. H. K. BOURNE on **Mercury Vapour Projector Lamps.** (*In the Sth. Wales Inst. of Engrs., Cardiff.*) **3.15 p.m.**

1945.

Dec. 6th. MR. J. G. HOLMES on **Methods of Glass Manufacture, etc.** (*At the Inst. of Engrs. and Shipbuilders, Elmbank St., Glasgow.*) **7 p.m.**

Dec. 6th. DR. J. N. ALDINGTON on **Bright Light Sources.** (*In the Great Hall, Manchester Coll. of Technology.*) **6.30 p.m.**

Dec. 7th. MR. A. L. RANDALL on **Maintenance and Operation of a Fluorescent Lighting Installation.** (*In the Electricity Showrooms, Bath.*) **7 p.m.**

Dec. 7th. DR. S. ENGLISH on **Illuminating Glassware.** (*In the Heriot-Watt College, Chambers St., Edinburgh.*) **6 p.m.**

Dec. 7th. MR. W. M. PEIRCE on **Modern Floodlighting Practice.** (*In the Lecture Theatre of the Gas Dept., Parliament St., Nottingham.*) **5.30 p.m.**

Dec. 10th. MR. N. SCHOFIELD on **Street Lighting.** (*In the Electricity Showrooms, The Headrow, Leeds.*) **6.0 p.m.**

Dec. 13th. MR. J. K. FRISBY on **Fluorescent Lighting.** (*In the Electricity Dept. Showrooms, Sunbridge Rd., Bradford.*) **6.45 p.m.**

Dec. 14th. MR. H. K. BOURNE on **Mercury Projector Lamps.** (*At the Imperial Hotel, Temple St., Birmingham.*) **6 p.m.**

Dec. 19th. A Brains Trust Meeting. (*In the Cleveland Scientific and Tech. Institution, Corporation Rd., Middlesbrough.*) **6 p.m.**

Dec. 20th. MR. E. G. PERNET on **Illuminating Advertising.** (*In Cheltenham.*)

1946.

Jan. 1st. Questions Night. (*In the Demonstration Theatre of the Electricity Dept., Charles Street, Leicester.*) **6 p.m.**

Jan. 2nd. Demonstration of Films—(" Let Us See " and " Street Lighting "). (*In the Electricity Showrooms, Whitechapel, Liverpool.*) **6 p.m.**

(Secretaries of Centres and Groups are requested to send in particulars of any changes in programmes, mentioning subject, author, place, date and time of meeting; summaries of proceedings at meetings (which should not exceed about 250-500 words) and any other local news are also welcome.)

1946.

Jan. 4th. Mr. L. C. Rettig on **Hospital and School Lighting.** (*At Radiant House, Bristol.*) **7 p.m.**

Jan. 4th. Mr. H. J. Cull on **The Physical Nature of Light.** (*At the Imperial Hotel, Temple Street, Birmingham.*) **6 p.m.**

Jan. 4th. Dr. J. H. Nelson on **Motor Car Lamps.** (*In the Lecture Theatre of the City of Nottingham Gas Dept., Parliament Street, Nottingham.*) **5.30 p.m.**

Jan. 7th. Mr. F. L. Cator on **Some Aspects of Lighting in the Engineering Industry.** (*At the Electricity Showrooms, The Headrow, Leeds.*) **6 p.m.**

Jan. 8th. Mr. F. L. Cator on **Some Aspects of Lighting in the Engineering Industry.** (*At the Electricity Showrooms, Market Street, Huddersfield.*) **7 p.m.**

Jan. 9th. Mr. H. C. Weston on **Presidential Address.** (*In the Minor Hall, Oxford Street, Newcastle-upon-Tyne.*) **5.45 p.m.**

Jan. 10th. Mr. A. L. Randall on **Electric Lamp Manufacture.** (*In the Electricity Dept. Showrooms, Sunbridge Rd., Bradford.*) **6.45 p.m.**

Jan. 10th. Mr. F. F. Middleton on **Lighting Pros & Cons.** (*In the Reynolds Hall, College of Technology, Sackville Street, Manchester.*) **6 p.m.**

Jan. 10th. Mr. H. C. Weston on **Presidential Address.** (*In the Cardiff Corporation Showrooms.*) **3 p.m.**

Jan. 10th. Mr. T. S. Wood on **Lighting and Hotel Services on Modern Liners.** (*At the Institute of Engineers and Shipbuilders, 39, Elmbank Street, Glasgow C.2.*) **7 p.m.**

Jan. 11th. Mr. W. Allen on **Daylight Design Practice.** (*At the Heriot-Watt College, Chambers Street, Edinburgh 1.*) **6 p.m.**

Jan. 16th. Address by Chairman of Group, Mr. E. Anderson. (*At the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.*) **6 p.m.**

1946.

Jan. 17th. Mr. A. G. Holtam, on **Factors Affecting the Efficient Working of Gas Street-Lighting Installations.** (*At Gloucester.*)

Jan. 23rd. Mr. J. K. Marsden on **Lighting in the Glass Industry.** (*At the Sheffield University, Western Bank, Sheffield.*) **6 p.m.**

President Visits I.E.S. Centres

Those who study the monthly calendar of I.E.S. meetings cannot have failed to observe the numerous demands for a repetition of the president's address as well as for his attendance at other functions.

To such appeals Mr. H. C. Weston has made a generous response, amongst the centres recently visited by him being Birmingham, Bath, and Bristol, Liverpool, Manchester, and Glasgow.

On the occasion of his recent visit to the Glasgow centre Mr. Weston in some degree combined the subject matter of his presidential address in London with that in his more recent talk on November 13. After making reference to the relationship of good lighting to good health he explained the construction of the new I.E.S. code and compared its principal features with those of the familiar version previously in use, pointing out the main departures and additions. He made it clear that a great deal of time and thought had been applied to the composition of this code illustrating his points by the aid of blackboard diagrams. He drew attention particularly to the treatment of daylight and to the manner in which the scientific background underlying I.E.S. recommendations was illustrated.

At the conclusion of the address Mr. F. M. Hale, who presided, recalled his early association with the president who had been personally responsible for a great deal of research on which this new code was based. On his suggestion members present gave hearty expression to their appreciation of the honour of receiving the president and cordially thanked him for his visit and address.

Cosine Response of Photocells and the Photometry of Linear Light Sources

By C. A. MORTON, B.Sc.(Eng.), A.M.I.E.E., F.I.E.S.

(Research Laboratories of The General Electric Co., Ltd., Wembley, England)

The portable photoelectric cell, whether built in with its indicating instrument, or with a flexible connection to it, has proved of considerable service to the illuminating engineer during the past ten years or so. Its general performance has been the subject of a British Standards Specification—B.S.S. 667—which deals with photo-electric cells and their associated indicating gear.

An important property of the rectifier photocell is its performance under oblique illumination. This subject is dealt with in the specification and is sometimes described as the cosine response, because the illumination on the cell varies directly with the cosine of the angle between the direction of incident light and the normal to the cell surface. If a photocell had a true cosine response the difficulties discussed in this article would not arise, because it would measure accurately all the light falling on it in all directions.

In practice, however, photocells generally give incorrect readings for light reaching them at very oblique angles. Fortunately, for many installations this is not serious; for example, in a factory using industrial dispersive reflectors mounted close to the ceiling the light reaching any point on the working plane at angles greater than 50 degs. to the vertical is only a small proportion of the total light reaching that point, and a photocell can give a usefully accurate indication of the illumination on a horizontal surface.

Error in the response of a rectifier cell to oblique illumination therefore does not generally form any limitation in its use on tungsten installations. With installations of long, fluorescent discharge lamps of the 5-ft. type, however, quite a different set of conditions may arise. Mounting heights of 5-ft. fittings are often low, and, in consequence, the cell is close to the light source. Therefore light from the lamp will reach the cell over a wide range of angles, and the effect of the "cosine response" of the cell may require particular consideration.

The problem that frequently arises, particularly in exploring the performance of a lamp in a single fitting, is whether it is more accurate to keep the cell surface horizontal, or to direct it to, say, the mid point of the lamp. The experimenter is faced with a dilemma; if he uses the cell horizontally its inherent errors become excessive, whereas, if he

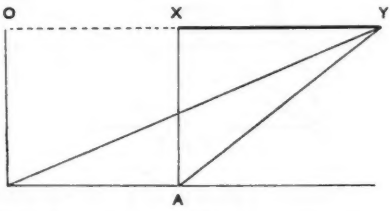


Fig. 1.

turns it normal to the centre of the lamp the full calculation becomes very complicated. For example, suppose we wish to examine the light distribution on a horizontal plane below a horizontal 5-ft. lamp in a vitreous enamelled trough reflector (see Fig. 1).

If the photocell is placed horizontally at A (vertically below the end of X of the lamp) and provided the angle XAY does not exceed 50 degs. the cell will measure sufficiently accurately the horizontal illumination. If we now move the cell away until it reaches a point B (where BO is vertical), the angle XAY becomes OBY, which may be larger than 50 degs., and the photocell readings will be incorrect; the farther away the cell is, the less accurate

will be its reading. A consideration of these points arose in a recent problem of the total integration of the light output of an industrial fitting suspended at a short distance above floor level. It was required to explore photometrically the complete area illuminated, and it was decided, therefore, to examine the results obtained with the two cell arrangements mentioned above.

In the analysis that follows, the first portion deals with the effect of the linear dimensions of the lamp on the flux picked up by the photocell in the alternative positions, and the latter portion deals with the response of the cell when used horizontally in positions where the limiting angle of 50 degs. is likely to be exceeded. The type of error discussed in the first portion will be referred to as the "linear" error, and that in the second portion as the "cosine" error.

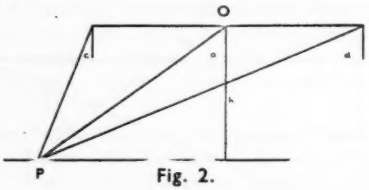


Fig. 2.

Consider a point P in a vertical plane through the axis of the lamp, and let the angles between the vertical and lines joining P to the centre and extremities of the lamp be a, c and d radians, as shown in Fig. 2. The horizontal illumination E_H at P can be given by the expression

$$E_H = \frac{B}{2h}\left\{(d-c) + \cos(d+c)\sin(d-c)\right\} \text{ ft.c.}$$

B is the lamp brightness in candles per foot length.

In a similar manner by the consideration of the cell surface at P at right angles to the ray OP, the expression for the illumination value E_N at P is

$$E_N = \frac{B}{2h}\left\{(d-c)\cos a + \cos(d+c-a)\sin(d-c)\right\} \text{ ft.c.}$$

where E_N is the illumination on a cell directed to the lamp centre.

In a similar manner we can consider points in a vertical plane transverse to the lamp axis. The process involves the introduction of terms not necessary in the preceding cases, but produces the interesting result that the values of the two expressions E_H and E_N have the ordinary simple cosine relationship.

Thus in points transverse to the lamp axis the cosine law is correct, and only the errors due to cosine response in the cell remain.

In the longtitudinal direction the two expressions already given must now be considered.

Had the illumination been received from a small source, the illumination E_H on a horizontal plane would have been $E_N \cos a$. In this case, however, $\frac{E_N \cos a}{E_H}$ is not unity and is given by

$$\frac{E_N \cos a}{E_H} = \left\{\frac{(d-c)\cos a + \cos(d+c-a)\sin(d-c)}{(d-c) + \cos(d+c)\sin(d-c)}\right\}\cos a$$

values of this fraction, which can be considered as a correction of the cosine law, are given in Table I.

TABLE I.

Ratio of Illumination Values $\frac{E_N \cos a}{E_H}$

Distance from Vertical Line through centre of lamp.	Mounting height above working plane.		
	2 ft.	3 ft.	4 ft.
0 ft.	1.00	1.00	1.00
1 ft.	0.86	0.95	0.98
2 ft.	0.70	0.86	0.94
2½ ft.	0.66	0.83	0.92
3 ft.	0.66	0.82	0.91
4 ft.	0.71	0.81	0.89
5 ft.	0.77	0.84	0.89
6 ft.	0.82	0.86	0.90
8 ft.	0.88	0.90	0.92
10 ft.	0.93	0.93	—
12 ft.	0.95	0.95	0.95

If we ignore the region immediately below the lamp, the ratio $\frac{E_N \cos a}{E_H}$ is seen to be always less than unity and only approaches it for a given mounting height as the distance is increased, or,

for a given distance as the mounting is increased. It also indicates that readings obtained by the second test method, with cell surface directed squarely to the mid-point of the lamp, will be lower than those obtained with the cell surface horizontal.

The figures shown above thus give a measure of the deviation from the correct illumination with the photocell directed squarely to the mid-point of the lamp consequent on the use of the simple cosine correction. The errors are solely the result of the linear dimensions of the lamp. The cosine response of the cell, which may be imperfect at angles greater than 50 degs. has yet to be considered as a further factor.

When the photocell is directed at the centre point of the lamp, the angles of incidence of light do not generally exceed 50 degs. and the cosine error is not serious, and the further the cell is from the lamp the more normally does the light fall on it; this is why it may be valuable to use the photocell in this way applying a correction factor given by Table I. However, it is more convenient to use the cell horizontally, but this involves a determination of the error introduced by faulty cosine response.

A photometric investigation on the cosine response of a cell used in the work mentioned, showed relationship within the specification limits up to an angle of 65 degs. At and beyond this angle the errors—the cell reading low—were

65°	70°	75°	80°
2%	8%	18%	39%

These figures were obtained for a point source, and the development of the complete cosine response error for a linear source involved a process of integration. This was carried out in the following manner.

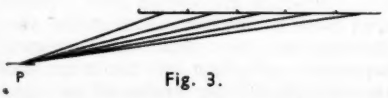


Fig. 3.

The lamp was considered to be divided into five equal sections. The angle of incidence of each section to the point P was calculated from the mid-point of the section. The limiting angles of each section, when referred to the cosine response calibration, gave the mean cosine response error of the section. The intensity of each section directed to the point P is proportional to its projected length normal to the line joining P to the mid-point of the section. The intensity contribution of each section was then corrected by the cosine response error, and the aggregate error of the lamp as a whole, due to error of cosine response of the cell, was found. A series of calculations was made for points in a line in the vertical plane through the same axis. The following results were obtained.

TABLE II.

Values of errors due to error in cosine response.

Distance from centre of lamp.	Mounting height above working plane,		
	2 ft.	3 ft.	4 ft.
5½ ft.	5%		
6½ ft.	10%	2%	
7½ ft.	16%	4%	
8½ ft.	21%	7%	2%
9½ ft.	27%	10%	
10½ ft.		14%	6%
12½ ft.			10%

The effect of these two corrections on photometric procedure can now be examined. Clearly, if both the correction due to lamp dimensions and the error due to cell response are known accurately, the cell may equally well be used in either position, and the appropriate correction applied.

If, however, the cosine response of the cell is not accurately known, the cell should be oriented always normal to the line to the centre of the lamp and the appropriate correction applied from Table I. If for any reason the correction from Table I. is not applied, then the cell should be used horizontally until the error due to cell cosine response is equal

to the correction from Table I. Thereafter it should be used normally. Fig. 4 indicates this condition. The values of the linear correction are all less than unity, and the departure from unity has been plotted as a negative error. The cosine response errors given are also negative.

It will be seen that for 2-ft. mounting height a horizontal photocell can be used up to a distance of 7 ft. from the centre of the lamp. Beyond this distance the cosine error is greater than that resulting from the use of a photocell normal to the centre of the lamp, using a simple cosine factor. At mounting heights of 3 ft. and 4 ft. the changeover points are at about 9 ft. and 10½ ft. respectively. The greatest errors, which will occur at the changeover points are −14 per cent., −8 per cent. and −6 per cent. respectively.

Both the linear source correction and the error due to cosine response are greatest for points in line with the lamp; for directions at right angles to its axis the former vanishes, and the latter is merely equal to the error for the angle of incidence for the mid-point of the lamp. The correction of the cosine error for oblique angles are both difficult to calculate, but can be estimated from the figures here given. If the linear source correction is not applied we may say, as a rough general guide, that for single 5-ft. lamps the changeover point from the horizontal cell to the normally directed cell should take place at three times the mounting height of the fitting when using a cell with good cosine response (i.e., comparable with the cell characteristics described previously). Even if only approximate results are required and the cell characteristics are unknown, the accuracy will obviously be improved if corrections are applied based upon Fig. 4.

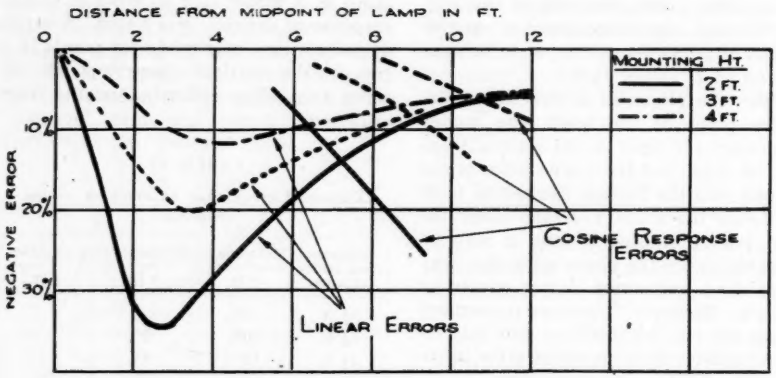


Fig. 4.

Although the errors of the horizontal cell surface method increase with distance, the illumination values fall, and the large errors that appear apply only to low intensities. For many purposes, therefore, it is quite satisfactory to use a horizontal cell, without applying a correction factor. It should be remembered, however, that in the experimental investigation mentioned, these low intensities are spread over a larger area close to the perimeter of the area illuminated, and thus, in aggregate, represent an output of luminous flux that should not be neglected in integration.

The New I.E.S. Code*

Proceedings at the Sessional Meeting of the Illuminating Engineering Society, held at the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C., at 6. p.m. on November 13th, 1945.

There was an excellent attendance at the I.E.S. Sessional meeting on November 13, when the President (Mr. H. C. Weston) introduced the new I.E.S. Code to members. This Code had already been widely circulated amongst members, but it was a great advantage to those present to hear the chief features lucidly explained by Mr. H. C. Weston. There was a good discussion, which was opened by Mr. H. E. Chasteney (Deputy Chief Inspector of Factories). In order to leave Mr. Weston quite free to discuss the Code and deal with queries, he was relieved on this occasion of the duties of chairman, Mr. Howard Long (senior vice-president) presiding.

In his introductory remarks Mr. Weston recalled the origin of the Code, originally issued in 1936, which has come to be widely adopted, and was used as a standard in factories engaged on national work during the war. He pointed out that whilst this well-known I.E.S. "Code," which hitherto has been concerned chiefly with values of illumination, has been thoroughly revised and considerably expanded, the new version, issued under the title of "I.E.S. Code of Practice for Good Lighting of Building Interiors," contains many new features of interest and value.

It is divided into two parts, dealing respectively with natural and artificial lighting. It also includes notes on assessing the amount of illumination required, together with a schedule of predetermined values for a large number of specific "visual tasks."

The Code defines good lighting in terms of amenity and utility. Lighting is "good" if it is suitable, in quality and quantity, both for creating agreeable environmental brightness and for permitting high efficiency in seeing what it is essential should be seen in any particular case.

Some informative diagrams are included in the Code. These refer to the duration of adequate daylight throughout the year, to the chief characteristics of different systems of lighting, to the permissible brightness of lighting units within specified angles of view, and to the determination of recommended values of illumination according to the nature of the "visual task." For the latter, two diagrams—termed I.E.S. Illumination Charts—are provided. One refers to natural lighting and gives values of daylight factor, while that referring to artificial lighting gives values of illumination, in lumens per square foot. These values form a geometric series, such that, by six steps, the illumination is multiplied tenfold. The charts are so designed that they give, at a glance, a maximum of information. Another important feature of the new Code is a section dealing with the quality of lighting and, in particular, with the avoidance of glare.

A departure here is the adoption of a sliding scale of maximum brightness of lighting units, which varies from 2.5 up to 10 candles per square inch according to the mounting height and the illumination provided. Special consideration is also paid to staircases and to local lighting.

The requirements in regard to "quality of lighting" are easily understood, and those familiar with the old

★A copy of this Code has been distributed to all I.E.S. members who habitually receive publications of the Society. Any member, however, who desires a copy, and has not yet received one can obtain one copy on application to the Illuminating Engineering Society, 32, Victoria Street, London, S.W.1. Additional copies or copies furnished to non-members will be supplied at the rate of 1/- each; special rates for larger numbers are obtainable on application.

Code will also discover that the actual values of illumination prescribed do not differ very widely from those formerly put forward—with the difference, however, that a specific value is indicated instead of the "range" formerly offered. Throughout the Code, also, values are now expressed in lumens per square foot, instead of the hitherto more familiar equivalent, "foot candles."

The Code is primarily intended for the guidance of those professionally engaged in planning and installing lighting, and their experience and skill will usually be required in applying its recommendations. It will, however, also guide the consumer in formulating his lighting requirements, or he may require compliance with it as a condition of any contract given for lighting.

The user, for example,can check, from the tabular data provided, the illumination needed for a particular process, even though he may not feel equal to applying the Illumination Charts so ingeniously contrived for the estimation of such values. (Mr. Weston did, however, show that the processes involved in using the charts could be executed by something resembling an "illumination slide rule," the various factors involved being thus brought into relation one with another.)

The introductory matter should be valuable in bringing home the fact that the provisions of the Code are based on the results of numerous scientific investigations. The Code, in short, is not based exclusively on current practice but has behind it a definite scientific background and should therefore be regarded as an authoritative document.

Motor-Car Headlamps and the Prevention of Dazzle

Dr. J. H. Nelson repeated his paper on the above subject to the I.E.S. Huddersfield Group on November 6, when he described in general terms the requirements to be met (a) on the open road when no other driver need be considered, (b) in situations when other vehicles are approaching and passing, and (c) when there is poor visibility resulting from mist or fog.

Condition (a) is met fairly easily by providing a beam candlepower of 40,000 to 100,000, and securing a distribution giving even brightness on the roadway. In the second case an additional passing beam, emitting only 300 to 500 c.p. towards the oncoming driver and directed substantially below the horizontal, is desirable. The solution of (c) is much more difficult owing to the scattering effect of mist. The colour of the light seems to be of small moment, but a beam designed to illuminate the roadway and the small layer of fog above it is helpful in revealing near objects. There was a good discussion which terminated in a vote of thanks to the lecturer, moved by Mr. T. C. Holdsworth, Chairman of the Leeds Centre.

Neon Signs

At a meeting of the I.E.S. Nottingham Centre, held on November 2, an address on "Neon Signs, their Manufacture, Installation, and Maintenance" was given by Mr. K. J. Oldham, who has great practical experience of this subject, and whose talk thereon had previously met with an appreciative reception at other I.E.S. Centres. Mr. Oldham followed the sequence suggested by the title of his address, dealing very fully with manufacture and stressing the importance of proper testing, cleaning, and technical supervision. He also pointed out, however, that "the best sign in the world may be ruined by bad installation," but paid a tribute to the painstaking efforts of erectors, often in the face of many difficulties.

The meeting took place in the City of Nottingham Gas Demonstration Theatre, and Mr. R. Gillespie Williams presided.

Reference was made to the next meeting, to be held in Derby, members present being asked to facilitate transport by the aid of their cars.

Inauguration Luncheon of I.E.S. Liverpool Centre

An enterprising and pleasing function, on October 30, was the luncheon arranged by the I.E.S. Liverpool Centre to celebrate its emergence from the chrysalis "Group" stage and its attainment of full Centre status.

There was an assembly of nearly 100 when the toast of "H.M. The King, the Duke of Lancaster, the City and Port of Liverpool" was proposed by the I.E.S. president (Mr. H. C. Weston), who, accompanied by Mr. R. Pye (secretary), had come up from London for the event. The Lord Mayor of Liverpool (The Rt. Hon. The Earl of Sefton) responded.

Following this there was an enlivening address by Mr. J. Eccles, the City Electrical Engineer, who, recalling the original fiat, "Let there be Light," remarked that members of the I.E.S. were following a great tradition. He alluded to I.E.S. progress in Liverpool, where the newly created Centre should go from strength to strength under the able leadership of its present chairman, Mr. A. E. Darlington, who presided over the luncheon.

Mr. Eccles remarked that this was probably the first public luncheon to be held in Liverpool by a technical society after the country's emergence from the crushing experience of six years of total war. The war, Mr. Eccles continued, had left us very much poorer than we were in 1939. It should be realised that nearly every country in need of goods had no money wherewith to pay for them. For the past six years, when we had been fighting for our lives, we had also been living on capital. Therefore, for years to come, we must adopt a Spartan existence, improving manufacturing methods, organising distribution, and bending our backs in honest toil in a manner unknown in this country during the past 50 years.

Never in the history of this island was there greater need for co-operation. Scientists and technicians were well aware what a long series of co-operative effort was necessary in converting raw materials into finished products. Fluorescent lighting, the latest achievement in the science of illumination, was an instance. Mr. Eccles enlarged on the many different materials incorporated in the fitting and the long series of technical processes by which it was fashioned.

Up till now, the speaker continued, emphasis in industry has been on the search for new materials and on increasing the efficiency of machines. In future this emphasis might shift to the human side of this problem. The present mechanised civilisation and the present circumstances called for a measure of co-operation and good will far beyond the old catch-as-catch-can principles of industrial practice and industrial strife.

In conclusion, Mr. Eccles emphasised the opportunities of service before members of the society, not only by showing competence in their work and giving inspiration by example, but by exhibiting an understanding sympathy with the lower deck "so that each one down to the cabin boy may have knowledge of their own part in the endeavour, and an assurance of their share in the reward."

Mr. A. E. Darlington, in moving a vote of thanks to Mr. Eccles for his address, expressed the belief that members of the I.E.S. would do their share towards assisting in the rebuilding of our social structure, and in conclusion reviewed the progress attained in Liverpool since its first meeting, as a Group, in November, 1944. He thanked the many friends who had assembled to make this function a success, and hoped that the gathering would become an annual event.

The luncheon was very well reported in the local Press, special prominence being given to the address by Mr. Eccles.

The president and secretary, besides enjoying the opportunity of meeting many friends and learning something of the doings of the Liverpool I.E.S. Centre were hospitably received and afforded an excellent opportunity of seeing some of the chief features of the city. A trip was

arranged through the Mersey tunnel to the Wallasey boundary and the docks in that vicinity, back to the Birkenhead entrance to the tunnel and on to the promenade of Seacombe Ferry, and finally from the pierhead to the shopping centres by way of the Liver building and the beautiful cathedral, which has mercifully survived almost unscathed from the hazards of war. The Mersey tunnel alone is well worth a visit, items of special interest being the photo-electric control and the sodium lighting at each entrance, carefully graded to facilitate the transition to daylight.

A Handbook on Illuminating Engineering

The "Handbook on Illuminating Engineering" now being prepared by the American I.E.S. is, it is stated, to be a very comprehensive five hundred-page work "dealing with every phase of lighting, from pure physics to specific lighting recommendations." The need for such a publication is felt to be urgent. In this country, too, there is a similar need. We understand that the I.E.S. Council has initiated the preparation of a suitable text-book, covering specifically the syllabus of the examination of the City and Guilds of London Institute in illuminating engineering, which, it is hoped, will become available next year. It will, however, presumably be of a simpler and more compact form than that contemplated in America.

Cold Cathode Lighting

At its meeting on November 8 the I.E.S. Liverpool Centre heard an address by Mr. Henry A. Miller on the above subject in which he referred to the provocative arguments on the respective merits of hot cathode and cold cathode lighting in the U.S.A. In this country conditions are hardly yet favourable for the development of a new lighting technique. Nevertheless, Mr. Miller suggested, in some applications cold cathode tubing may have a field of its own.

Illumination : Is it an Art?

Chairmen, in their addresses to I.E.S. Centres, are evidently following lines of their own and producing some distinctive efforts. In his recent address to the Nottingham Centre Mr. R. Gillespie Williams answered the above question by declaring that there is an art of illumination. By "art," however, he meant the "application of skill and taste according to aesthetic principles," rather than "dexterity, adroitness, and cunning." Mr. Gillespie Williams referred more specifically to certain fields of lighting recognised to have scope for artistic effort, e.g., stage lighting and decorative colour lighting. But he instanced other opportunities for creative work and lamented that, in the discussion of illuminating engineering, relatively little consideration is customarily given to aesthetic aspects. Certainly there is a need for discussion—the difficulty rather seems to be to reduce these principles to a concrete form so that the ordinary user of light may have something which he can understand and apply.

Fluorescent Lamps

Mr. T. C. Holdsworth, the chairman of the I.E.S. Leeds Centre, in his address followed more conventional but, nevertheless, useful lines by giving a review of the development of discharge electric lamps and fluorescent lighting. In so doing he answered a great many questions, which are somewhat apt to be overlooked in papers in which common knowledge is taken for granted, explaining in broad terms how fluorescent lamps operate and the nature of the gear to be used with them. He had something to say, too, about operating conditions, discussing, for example, stroboscopic effects and their prevention and the influence of voltage fluctuations—which may be more considerable than is commonly imagined. He terminated his address by giving a series of hints in regard to the installation and servicing of the lamps in practice.

*(We hope to deal more fully with some of these papers and addresses in a subsequent issue.—*ED.)

Street Lighting

The paper on this subject, read by Mr. E. C. Lennox before the Institution of Electrical Engineers on November 8, covered a very wide ground. In his opening remarks the author reminded his audience that (with the exception of "starlight," "dim-out," and other A.R.P. devices) there had been no developments in street lighting since the outbreak of war. We now started, therefore, where we left off in 1939. The war has, however, helped to stamp home the need for adequate lighting. Mr. Lennox alluded to the great increase in street fatalities during the period of the blackout, and expressed his belief that adequate street lighting was a major factor in minimising street accidents—a point of importance for the future, when progressive increases in vehicular traffic might be expected.

Turning to principles, Mr. Lennox discussed the two alternative methods of creating contrast between an object of the roads and its background: (a) by illuminating the object to a degree of brightness greater than that of the background, and (b) by creating a "background brightness" against which the object can be seen in silhouette.

The first of these methods is difficult to achieve with conventional lighting systems, partly because of the nature of road surfaces of the present day. The second method has been widely adopted, but this again offers a choice between the "cut-off" and "non-cut-off" systems. The former, in which light is cut off at angles above 70 degrees to the downward vertical, has the advantage of minimising glare but rendered difficult the production of an area of high and even brightness, unless lamps are spaced relatively near together, With non-cut-off lighting, yielding a maximum c.p. at 75 degrees or above maintained up to about 86 degrees, high and even brightness may be more readily secured, but the tendency to glare is necessarily greater. Mr. Lennox pointed out, however, that good light-reflecting qualities on the part of the background—not only road surfaces but surfaces of buildings, palings, etc.—are of considerable importance, and that proper siting of lamps, e.g., at bends of the roadway, road intersections, and roundabouts, also plays a vital role. Some reference was also made to the use of special unidirectional lighting units on carriageways or one-way roads where traffic proceeds in one direction only.

After touching on the British Standard Specification for Street Lighting and the familiar report of the M.O.T., Mr. Lennox reviewed the design of lanterns, poles and columns, and equipment for present use, expressing a preference for closed-type dustproof fittings. The coming of an anodised aluminium reflector must be taken into consideration, but the author preferred placing full reliance on refractor glassware, for which, however, adequate focusing facilities are of importance.

Dealing with discharge lamps, the author pointed out that whilst, from the traffic standpoint, there seems to be no objection to any particular colour, nothing is worse, for general effect, than a patchwork of coloured lighting on small areas. For civic centres and promenades combinations of lamps, giving fairly normal coloration, seemed desirable. After a brief reference to methods of control, including high-frequency impulses, d.c. injection, etc., the author touched on administration problems, ending his paper with a series of tables in which instructive data on comparative cost of equipment, costs per mile of various classes of roads, etc., were incorporated.

In the discussion that followed a considerable amount of comment was made on the merits of cut-off and non-cut-off methods. A number of those present emphasised strongly the desirability of diminishing glare and the possibilities of the cut-off system in this connection.

Illumination and Public Health

There is one section of people whose views in regard to the value of good lighting naturally carry great weight with the public, the medical profession. Yet, in the ordinary way, little or nothing about illumination finds its way into their courses of training, and a great opportunity of enlisting their help is thus lost.

One is the more gratified, therefore, to note that in the first course for the Diploma of Public Health, recently entered upon at the London School of Hygiene and Tropical Medicine, room is being found for lectures and demonstrations dealing with illumination. Those who enter for these courses are all qualified doctors, and most of them are ex-medical officers from the Fighting Services.

Dr. T. C. Angus, who is associated with this effort, has kindly sent us a copy of the syllabus, which is evidently specially prepared to meet the needs of the audience. It deals with the needs of the eye, its reaction to light, its sensitiveness to glare, and the effect on its powers of increasing illumination. This leads to notes on the measurement of illumination, the requirements of the Factory Act, and the new I.E.S. Code.

The lighting demonstration rooms at the college suffered grievous damage from air raids during the war, but are now being reconstituted, and the equipment will, it is hoped, be completely restored in course of time.

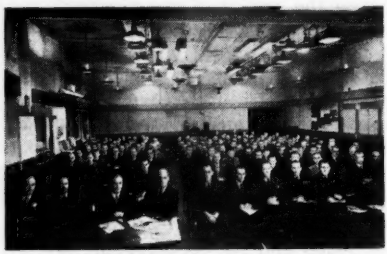
New G.E.C. Directors

We learn that Mr. W. Horsefall, Mr. F. Lonsdale, Mr. R. E. Robinson, and Mr. W. H. Williams have been appointed to the board of the General Electric Co., Ltd. Mr. W. H. Williams, who has been with the G.E.C. since 1916, and, in collaboration with the late Mr. J. Y. Fletcher, has been intimately connected with the electric lamp industry, was recently chairman of E.L.M.A. He is also, we understand, an I.E.S. member of very long standing.

E.L.M.A. Illumination Design Course

One notes with pleasure another sign of return to more normal conditions—the initiation of the 41st E.L.M.A. Illumination Design Course, the first post-war event of this kind. If one may judge from the attendance, the course seems to be proving as popular as ever. The photograph is evidence in this respect, though it should be mentioned that on the opening day many people were delayed by fog, and the full attendance, which subsequently reached 148, was not then attained.

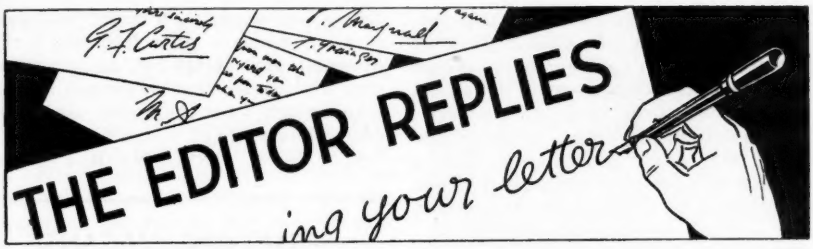
Readers will be interested to note the



The audience seen from the back of the lecture theatre. On the platform are Mr. H. A. Lingard, Chairman of the E.L.M.A. Council, who opened the Course, and Mr. W. J. Jones, M.Sc.,M.I.E.E., who gave the first lecture on "The New Outlook on Lighting."

presence of Mr. W. J. Jones, who has been identified with this effort ever since its inception, and who, on this occasion, was responsible for the first of the series of lectures.

We are reminded by the above of the similar success of the series of lectures on "Modern Developments in Industrial Lighting" that has just been completed at the Leeds College of Technology and to which we made reference in our October issue (p. 136). We learn from Dr. Walton that the initial enrolment was 74, and that it is hoped to start a regular course in illuminating engineering at the college next session.



Fluorescent Lamps and their uses continue to excite comment. There seems to be a general and probably justified belief amongst architects and decorators that even the low brightness of these sources demands screening—except, perhaps, when mounted at ceiling level. Even in that case a surrounding envelope of diffusing material may have an agreeable effect and serves the useful purpose of illuminating better the horizontal surface on which the lamp is mounted (always liable to prove a difficulty with direct ceiling mounting).

Many people prefer the **"warm, white"** type of lamp, though somewhat less efficient. I have the impression that the effect is more pleasing for flower shops than that of the **"daylight"** variety, even though the colour may be less faithfully rendered. There is doubtless some ground, too, for the feeling that the daylight tint is "chilly"—though I have been assured that this is largely a question of the degree of illumination provided, and that with values approaching those received from natural daylight the impression of coldness disappears. The pleasing installation at Piccadilly Circus station, recently mentioned in this journal, rather bears out that view.

I am indebted to Mr. J. B. Carne for a copy of a letter from a lady correspondent to the "Sunday Express," who makes several questionable assertions; that **small print is better for the eyes than large print,** that "screwing up the eyes" is due to unsuitability of lighting rather than inadequate quantity, and that **candles are among the least harmful of lights.**

I think that very few people of middle or later age would prefer small print to large! Doubtless there are many who, like myself, have great difficulty in reading the small print in the Prayer Book, and, indeed, can only do so by the aid of relatively high illuminations.

From the hygienic standpoint **the candle has one merit, its low brightness,** but against this the light is unsteady, inconveniently distributed and deficient in intensity. I had a convincing illustration of this recently when, owing to a temporary failure of the electric light, dinner had to be eaten by the light of several candles. The contents of one's plate could be seen only very imperfectly—it was, for instance, most difficult to distinguish and separate small bones from the fish!

Dr. T. C. Angus sends me a copy of a letter, entitled **"It Makes You Think,"** recently addressed by him to the *Electrical Review*. He mentions that case of a head mistress of a school, now being re-established in the Home Counties, who wishes the **classrooms to be lighted in accordance with I.E.S. recommendations,** but at present has been unable to find anyone to help her.

It certainly does seem a shame that when one **does** find a teacher desiring good lighting she should thus be faced

by difficulties. We commend this case to the attention of I.E.S. sustaining members, some of whom surely should be able to meet the need if it has not yet been satisfied. I suspect, however, that the difficulty may be associated with the usual problem of getting priority for essential equipment, or the prevalent shortage both of labour and materials in these troublesome times.

Dr. Angus also states that he does not know of any contractor or manufacturer of electrical equipment who **habitually announces that he has specifications** such as those proposed by the I.E.S. and is prepared to work to them. Here, I think, the weakness lies partly in the absence of clear and authoritative guidance in many fields of lighting which the **Codes of Practice** now being prepared should ultimately help to make good.

My attention has been drawn to accounts in the Press of recent **applications of science** for the **detection of crime,** such as the use of ultra violet analysis and of the epidiascope. The use of U.V. tests to reveal forgeries of documents, etc., is of old standing. The treatment of tickets and vouchers with fluorescent material (revealed under "black light" as a proof of genuineness) is more recent, though the adoption of this device quite recently for race meetings in this country was apparently preceded by similar action in America some little time ago.

The **use of the epidiascope** to project large images of objects on the screen, so that minute irregularities can be enlarged and studied, is a natural development. It has been used by, amongst others, philatelists concerned with details in the dies of postage stamps. One can quite understand its usefulness for the technical examination of "clue-objects" in connection with crime.

Readers will probably not wish me to enter further into the **"much"** and **"very"** controversy. I ought, however, to acknowledge a letter from Mr. G. F. Freeman, who points out, quite rightly, that whilst adjectives in general do not take "much" it is invariably used with comparatives (e.g., "much brighter," "much easier," etc.). Mr. R. Pye has drawn my attention to a passage in "A Dictionary of Modern English Usage," by H. W. Fowler, discussing this rather mysterious problem in detail. Incidentally, I may commend this useful work of reference to those interested in questions connected with style and literary expression.

War Time Developments in Industrial Lighting Technique

In the years preceding the war there was already a growing appreciation of the direct relationship between illumination and industrial efficiency. The revision of the Factory Act in 1937 provided for two important requirements, *sufficiency* and *suitability* of lighting. In a Departmental Report issued in 1938 matters were carried further, special consideration being paid to avoidance of glare.

With the coming of war, industrial lighting became of growing importance. Every possible means of increasing essential production was considered and the effect of better lighting, both as regards quantity and quality of work, was recognised. Moreover, the sudden imposition of war conditions raised new problems. The black-out had an immediate and drastic influence on factories, where frequently much of the glass normally admitting daylight had to be permanently obscured. Hitherto well-lit workrooms were darkened, and even in the daytime had to rely greatly on artificial illumination. This had a definite psychological effect to which the strain of longer working hours, increased stress of work and the use of inexperienced workers, usually of a higher age, all contributed.

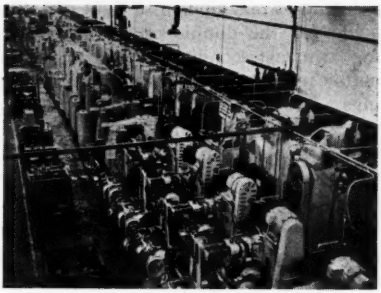


Fig. 1. A view of a factory showing the appearance of a series of machines painted in light colours. A light colour is also adopted for the wall seen in the background.

Fig. 2. Another view showing special work in a room lighted by overhead fluorescent lamps, with light coloured walls and ceiling.

As a result, not only the *amount* of artificial lighting but its *nature* was more closely studied. Hitherto the chief criterion of good lighting had been illumination on the working plane. Symmetry of layout was another consideration, but in spite of this installations often lacked "harmony"—distracting the attention of operatives instead of aiding concentration. It appeared necessary to study the subject from a more human aspect, involving consideration of the subjective effect of surroundings. These effects were studied by Messrs. Crompton Parkinson, Ltd., in their own works, and the knowledge obtained was subsequently used in developing schemes elsewhere.

In its most blatant form direct glare is readily recognised, but there are less obvious manifestations which are also of moment—such as the indirect glare caused by reflection of light from polished surfaces and the effect of extreme contrast when even moderately bright objects are viewed against a dark background.

Both are apt to be in evidence when machine tools having highly polished surfaces are contrasted with other surfaces of a dull and dark colour. Consideration of such conditions led to the

painting of machines in a light tint, thus achieving the double object of improving contrast conditions and obtaining better reflection of light from surroundings. In this connection consideration must be given both to the reflection coefficients of the paints adopted and to the spectral composition of the source illuminating them.

These circumstances were taken into account in the relighting of a large factory where the original illumination, provided by tungsten filament units at a height of 10 to 12 ft., was 8 to 10 ft.c. A drawback to the system was the "tunnel effect" produced by the dense shadow above the level of the fittings. In addition the distribution of illumination was uneven. When the installation was remodelled the original fittings were raised to a height of 14 ft. and an installation of high-pressure mercury vapour lamps, 25 ft. high, was superimposed, resulting in a rise in illumination to 12-14 ft.c.

In addition to this improvement in the lighting all machinery was painted in a light shade of green (eau-de-nil), and all wall surfaces, stanchions and other structural features were treated in other contrasting light tones, buff being used for the most part. This colour scheme was appreciated by operatives as an effort to produce pleasant surroundings. The standard of cleanliness also improved, as grease and dirt became more noticeable. Production advanced and absenteeism and accidents diminished.

Experience in this first installation has been applied to many others. Combinations of tungsten and mercury vapour lamps, which provide a colour effect very similar to that of daylight, have given satisfaction and in certain instances—e.g., in foundry work—the line spectrum of mercury sources is found to have special advantages in giving clear definition.

Local lighting, often necessary for small and intricate work, has also been the subject of study. Such light should be combined with moderate general lighting and indirect glare from polished surfaces near the eyes must be carefully avoided. Here, too, a background of moderate brightness is helpful. Light sources having large surface areas of low brightness are particularly acceptable for local lighting, and this helps to explain the popularity of the fluorescent tube. Even with such lamps, however, provision for some light to escape upwards and eliminate the "tunnel effect" is desirable. The degree to which stroboscopic effect is noticeable with fluorescent lighting is very small, but can be practically eliminated by placing adjacent units on different phases or by adopting series condenser connections alternately with direct connections from the inductance of the lamps.

Local lighting is required with many machines, especially with those having a heavy overhang above the tool. If, however, the reflection factor of adjacent surfaces is maintained near 50 per cent. (instead of 5 per cent. as often occurs) the effective illumination may often be doubled or trebled.

In conclusion the choice of colours, to produce stereoscopic effect, causing machines to "stand out" to give distinction and to produce a pleasing atmosphere—a complete symmetrical and pleasing whole—is well worth study.

We are indebted to Messrs. Crompton Parkinson, Ltd., for the information and photographs included in this article.

B.S.I. Publications

Two recently issued publications of the British Standards Institution deserve notice: A Schedule for Electric Discharge Lamps for General Purposes (No. 1270/1945; price 1s. net, post free) and a British Standard specification for Visual Indicator Lamps (No. 1950/1945; price 2s. net post free).

The Schedule gives particulars of rating, dimensions, etc., and is to be followed by a complete specification for discharge lamps in due course. The other publication refers to visual indicator lamps as used on telegraph and telephone switchboards, etc. It specifies the requirements, conditions of test, and basis for rejection, and, in conclusion, deals briefly with photometry.